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Catopsilia scylla (Linnaeus, 1763): A new record for Sri Lanka with notes on its biology, life history and distribution (Lepidoptera: Pieridae)

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Abstract. *Catopsilia scylla* was recorded for the first time in Sri Lanka in February 2008 and has been recorded since then in over 25 locations in the south-west quadrant of the island. Its larval food plant is *Senna surattensis* (Fabaceae: Caesalpinioideae), a widely planted introduced garden plant. The immature stages and behavior in Sri Lanka are documented here for the first time.

Keywords: Lepidoptera, immature stages, life history, larval food plants, Sri Lanka, Pieridae.

Introduction

Catopsilia scylla (Subfamily: Coliadinae; Tribe: Coliadini) comprises 10 subspecies that are widely distributed in southeast Asia and Australia from eastern Pakistan through Indo-China including Burma, the Malay Peninsula, Sumatra, Java, Lesser Sunda Islands, Borneo, Palawan, Philippines, Sulawesi Region, North & Central Maluccas, the Bismarcks, some of the Solomon Islands, northern Australia, New Caledonia and Fiji (Parsons, 1998; Vane-Wright & de Jong, 2003). It has recently been reported in Taiwan (Lu & Hsu, 2002). *C. scylla* is not found in India and has not been previously reported from Sri Lanka though *C. pomona* and *C. pyranthe* are common species there.

C. scylla was first identified in Sri Lanka by the authors on February 16, 2008 flying near *Senna surattensis* plants at km 58 on the A10 highway (the Kurunegala-Wariyapola road) in the North Western Province of Sri Lanka (7° 34' 60" N, 80° 16' 60" E). Several adult males and females were seen flying near the plants and feeding on the nectar of flowers of *Caesalpinia pulcherrima* shrubs planted nearby. The *Senna surattensis* plants were laden with eggs, larvae in all instars, pupae and pupal cases. Several specimens of *C. scylla* were also identified later that day in the authors' home garden (Bandarakoswatte, road B79 at km 44 about 12 km away from the original sighting). In fact, on February 4, 2008, the authors had noted in their field records "a very yellow *Catopsilia pomona*" [form pomona] at their property—very likely this was the first sighting of *C. scylla*.

A subsequent search over the next few weeks revealed adults and larvae at several other locations, most of them within 20 km of the original sighting. Other sightings ranged north to Padeniya, west to Pannala and Bingiriya, south-west to Rajagiriya and Colombo, south to Galle and Rumassala and south-east to Uduwalawe and Embilipitiya. Since then, it has been recorded at about 25 locations in the west, south, south-west and south-east of the island in most months of the year but is most common from January to April and September to December (Fig. 1).

Where information on the duration of developmental stages is given, these data were obtained in rearings at ambient temperatures (25–31°C) at Bandarakoswatte (07.37.01N, 80.10.57E), 70 m asl, North Western Province, Sri Lanka. Conventions used (applied to both the larva and the pupa): Segments are numbered S1 to S14 (S1—the head; S2 to S4—the 3 segments of the thorax; S5 to S14—the 10 segments of the abdomen).

Specimens (2 males and 2 females) have been deposited in the Sri Lanka National Museum.

Results and discussion

Adults: Wingspan 60-65 mm. Little or no variation

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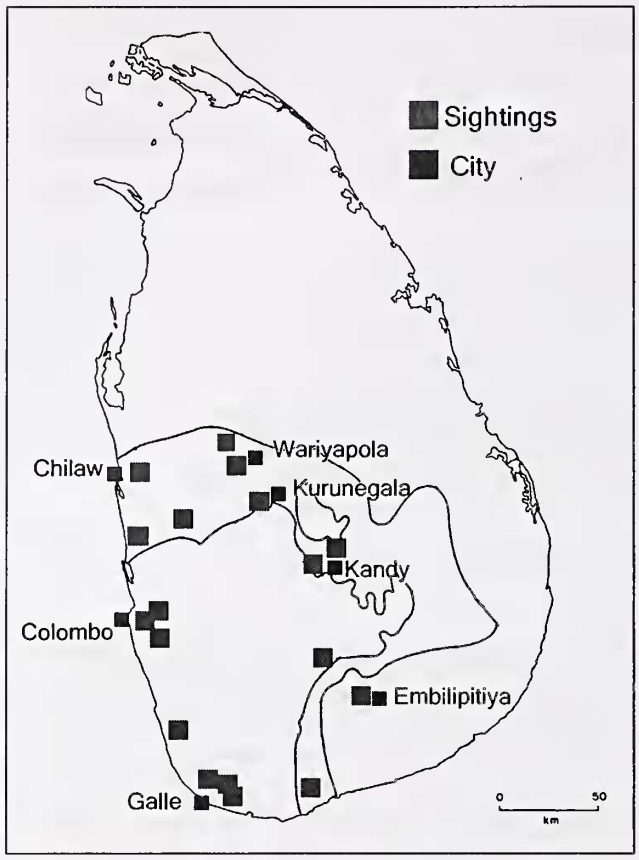

Figure 1. Distribution map of *C. scylla* in Sri Lanka.

has been observed in the adults. In the male the upperside of the hindwing is a cadmium-yellow without any orange; in the female the color is a less intense lighter yellow. There is no cell-end spot on the upperside of the forewing in the male (Fig. 2a) though there is a faint one in the female (Fig. 2b) which corresponds to the spot on the underside. The dark markings on the underside of the wings are purplish-brown (Fig. 2c). Though Braby (2004) reported a rare, pale, polymorphic form of the female in Australia, no such individuals have been reported in Sri Lanka up to now. Despite its distinctiveness in the hand, *C. scylla* may be superficially confused with *C. pomona* (form pomona) in flight. Nevertheless, it is distinctly smaller than *C. pomona* and has a slightly slower flight.

Subspecies: Specimens of *C. scylla* from Sri Lanka were compared to specimens in the NHM London, the Linnaean Society of London and MCZ at Harvard. The males of all 10 subspecies appear to be fairly similar though the color of the hindwing varies from orange to chrome-yellow; the females vary in the size and boldness of its markings, some being heavily marked, others quite lightly marked. It has not been possible for us to determine by morphological appearance to which subspecies the specimens in Sri Lanka belong. Though most of the subspecies of *C. scylla* are variable in appearance, the individuals examined in Sri Lanka are quite invariable. The expression of the phenotype in Sri Lanka might differ from the parent stock from which it originated because of differences in photoperiod and temperature between the two locations. Nevertheless, the closest resemblances are to *C. s. scylla*, *C. s. etesia* and *C. s. cornelia*. Molecular studies are needed to determine its origin with certainty.

Behavior: The general behavior of *C. scylla* is similar to that of *C. pomona* but its flight is slower and it feeds more readily on flowers of herbaceous plants near the ground. Males are frequently seen near the larval food plant, presumably looking for females as they fly in and out of these small trees. Males have been observed mudsipping during dry weather. Females, as expected, were also observed mostly near the larval food plant seeking suitable oviposition sites. Both sexes feed on the nectar of flowers.

Female oviposition behavior: Eggs were laid singly on the lower or upper surface of a completely expanded leaf (Fig. 2d). Neither young shoots nor tender leaves, which are commonly used by *C. pomona* and *C. pyranthe*, were used for oviposition. The females deposited their eggs very rapidly and settled almost vertically whether they were laying on the upper- or under-side of the leaf. Most preferred to lay their eggs within 2 m of the ground and only a few oviposited above this height. Within a minute or two, they moved to other plants in the vicinity, deposited more eggs and moved on. Though some females were ovipositing on plants situated along a busy highway, they seemed unconcerned and were not driven away by the gusts of wind that swept through the trees as the large buses and trucks sped past on both sides of the road.

Courtship and adult nourishment: Courtship appears to be absent. On March 2, 2008, the authors observed a female being mated as soon as it emerged from the pupa, with no apparent choice by the female. On another occasion, a female who had just flown from its pupal case was intercepted immediately by a male flying by and mated; both settled down on a herbaceous plant near the ground. On one occasion, a mated pair remained in copula for 1 hour, 32 minutes—a time period that seems very long, although this may not be usual.

Adults feed on the nectar of a number of common plants. Some are naturalized plants that are a favorite nectar source for many species of butterflies—these

Figure 2. Adult *C. scylla* butterflies from Sri Lanka. **a**. Male, upperside. **b**. Female, upperside. **c**. Undersides, female on the left, male on the right. **d**. Female ovipositing on *Senna surattensis*.

include *Stachytarpheta indica*, *Chromolaena odorata* and *Cordia curassavica*. Others are not naturalized but are widely planted—these include *Duranta repens*, *Pseuderanthemum latifolium*, *Zinnia* spp. and *Caesalpinia pulcherrima* (a favorite of *C. scylla*, perhaps in part because it is often planted beside *S. surattensis* on the roadsides). Still others, such as *Urena lobata* and several species of *Sida*, are native. This propensity to feed on the nectar of a wide range of common plants has probably contributed to its rapid expansion and colonization of new areas.

Members of the genus *Catopsilia* are reported to be migrants in many different countries including India (*C. pomona* and *C. pyranthe*, Larsen, 1978), Australia (*C. pomona*, Braby, 2000) and Africa (*C. florella*, Larsen, 1992). In Sri Lanka, *C. pomona* and *C. pyranthe* have been recorded migrating twice a year starting near the beginning of each monsoon season (i.e. February-April & October-December) (Williams, 1927). Manders (1904) reported the direction of flight of *C. pyranthe* and *C. pomona* as being south from Trincomalee down along the east coast, west along the southern coast and north up the west coast. He further reported that *Catopsilia* butterflies all began to migrate at the same time, regardless of what part of the country they lived in. He found that the majority of the specimens in the October to December flights were females who were desperate to lay their eggs and laid them indiscriminately on any bush. The authors have noted *C. pyranthe* and *C. pomona* migrating to the south from their home location at Bandarakoswatte in April and October. There are no reports of *C. scylla* being migratory though Braby (2000) speculates that it is almost certainly migratory in Australia. But in Sri Lanka, *C. scylla* appears to engage in migratory behavior. When they were first identified in 2008, they appeared to be moving in numbers towards the south and south-east. Further observations seemed to show that it disperses widely but not in any particular direction. Adults have a strong tendency to fly along

roadways perhaps because its larval food plant, *Senna surattensis*, is frequently planted along these roads.

Immature stages: The final instar larva and pupa were briefly described by de Nicéville & Martin (1895) (quoted in Parsons, 1998): the larva is "dark velvety green, with a yellowish-white lateral stripe, and ... minute black dots on the upper edge of this stripe are most dense on the thoracic segments" and "the pupa is similar to that of *C. pomona* but [slightly] shorter and more convex (i.e. less slender than that of *pomona*)." These brief descriptions agree with the investigations of this study. In addition, we have recorded the following:

Egg: 1 mm × 0.3 mm, white, spindle-shaped, more slender and stalk slightly narrower than in *C. pomona* (Fig. 3a). 1st instar: completely white on emergence, next day turned pale yellowish-green with a pale yellow head (Fig. 3b), ate tissue on the underside of the leaf on either side of the midrib leaving the upper epidermis intact which later dries up to leave a small hole in the leaf that gives away the presence of the larva (Fig. 3c), ate old leaves as well as young ones, rested along the midrib of the leaf on the underside, movement somewhat looper-like. 2nd instar: head light green with small black tubercles, body paler green, rugose, each segment with 4-6 furrows, each furrow with numerous small black protuberances, each protuberance with several fine setae, indistinct spiracular line, ate tissue from the margins of the leaf, rested along the upperside of the midrib of the leaf or along the leaf rachis, fed mostly at night (Figs. 3d). 3rd instar: same as 2nd but with a faint white spiracular line (Fig. 3e). 4th instar: same as 3rd instar, white spiracular line (sometimes faint) with a tinge of yellow on its upper margin, larger black spots just above spiracular line (Fig 3f, g). 5th instar: head same color as body or slightly lighter or yellowish, abdomen green to greenish-yellow, spiracular line cream to white, sometimes with a tinge of bright yellow on its upper margin; each segment transversely ridged (4-6 ridges per segment), each ridge with 20–30 small raised black protuberances on each of which are found several black setae, size of the protuberances variable but those just above the spiracular line are the largest within each ridge though they may be absent toward the last few segments, those on S3–S5 are the largest (Figs. 3h–j). The larva is very similar to that of *C. pomona* but can be distinguished by the black protuberances above the spiracular line. In *C. pomona*, they are large and prominent along the whole length of the abdomen while in *C. scylla*, they are most prominent in the thoracic region and absent or not prominent on the other segments. In all instars, the molted cast-off skin is often eaten by the larva. The

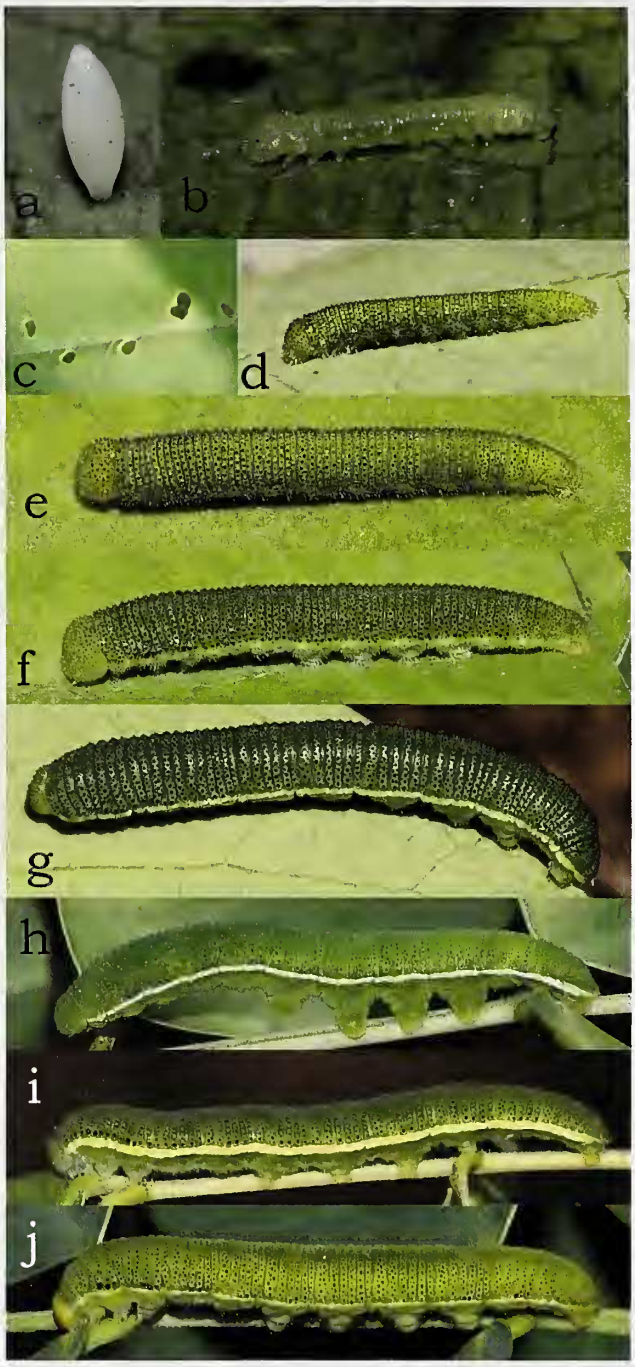

Figure 3. Early stages of *C. scylla* from Sri Lanka. **a**. Egg. **b**. Larva, first instar, one day after emergence. **c**. Holes in leaf left by first instar larva after eating. **d**. Larva, second instar, one day after molt. **e**. Larva, third instar. **f**. Larva, fourth instar, with faint, interrupted spiracular line. **g**. Larva, fourth instar, with complete white spiracular line. **h**. Larva, fifth instar, green head and body with few black supraspiracular spots. **i**. Larva, fifth instar, green head, yellowish-green body with numerous black supraspiracular spots. **j**. Larva, fifth instar, yellow-green head, yellowish-green body.

first two instars fling their frass. The larva frequently rests with the upper half of its body raised and is quite unresponsive to disturbances, hardly moving when touched. The larvae seem to be quite tolerant of an unclean environment: those found on *S. surattensis* plants along the roadways fed readily and survived well on leaves that were covered with a thin layer of soot and dust. Pupa: with a faint white lateral line from S1–S7, more sharply defined white line from S8–S13 and yellow on S14 (in *C. pomona*, this line is completely yellow), horn light yellow at tip (in *C. pomona* with a black dot), S4–S8 and S9–S14 more convex particularly on the ventral side, spiracles white; color ranges from green to yellow (Figs. 4a, b); pupa loosely fastened to the substrate (Fig. 4c).

Length of larva (mm): on emergence (4); after 3rd molt (16); at maturity (32–43); pupa (26-30). Duration of immature stages (days): Egg (1–3); 1st instar (1–3); 2nd (2–4); 3rd (1–3); 4th (3–4); 5th (4–5); pupation (1); pupa (7–11); egg–adult (24–32).

Larval food plants: In Sri Lanka, the only confirmed larval food plant is *Senna surattensis* (Fabaceae) which is an introduced small tree. It is widely planted but does not yet appear to have become naturalized. It produces large amounts of viable seeds but because the pods remain attached to the plant and do not dehisce, the seeds do not fall to the ground to germinate and eventually rot on the tree (Fig. 4d). Since *S. surattensis* is planted as an ornamental, it is restricted to urban and semi-urban landscapes. *C. scylla* is found only in such habitats and has not yet established itself on other plants in forest settings unlike *C. pomona* and *C. pyranthe*.

Larval food plants used by *C. scylla* have been recorded for several other countries. For the Sulawesi area, Vane-Wright & de Jong (2003) reported *Crataeva* (Capparaceae), *Cassia, Senna* and *Tephrosia* (Fabaceae). In Australia, Braby (2000) reported *Senna leptoclada, S. retusa* and *S. surattensis* (an introduced plant) while Wells and Houston (2001) also included *Senna didymobotrya* (introduced). In Papua New Guinea, Parsons (1998) reported that *Cassia spectabilis* [now *Senna spectabilis*] and *C. tora* [now *S. tora*] were used. Corbet & Pendlebury (1992) reported *Cassia fistula* and *C. obtusifolia* [now *Senna obtusifolia*] from Java, and that "larvae were found on *Tephrosia candida*" in Malaya. In Singapore, where *C. scylla* is a common urban butterfly, *Cassia fistula, C. biflora* and *C. tora* are used.

There are 30 species of *Senna* and *Cassia* in Sri Lanka (Dassanayake, 1991) including many that are used as larval food plants in other countries. It is possible that *C. scylla* may utilize some of these as

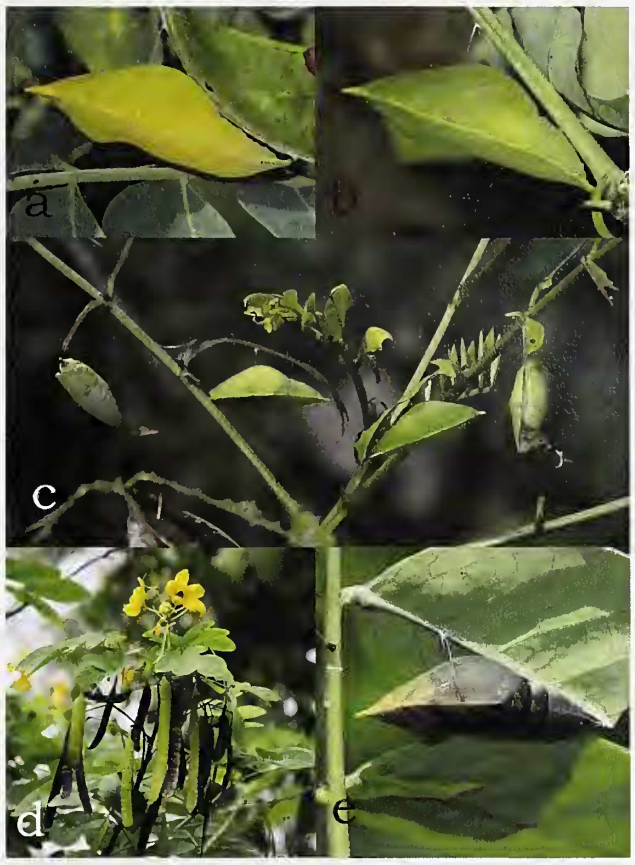

Figure 4. Pupa and host plant of *C. scylla* in Sri Lanka. **a**. Pupa, yellow form. **b**. Pupa, green form. **c**. Pupae loosely connected to substrate. **d**. *Senna surattensis*, flowers and pods. **e**. Pupa with fungal infection.

larval food plants in the future. In 2010 (February 15-20), a female was observed laying eggs on *Cassia auriculata*, a small tree native to Sri Lanka, called "ranawara" in Sinhalese. Eggs were collected with difficulty as they were laid high up, but the larvae all died within a few days of hatching out though they ate the leaves readily. Other eggs that had been laid by *C. pyranthe* on the same plant hatched out and were raised successfully. It is possible that some larvae of *C. scylla* might be able to survive on *C. auriculata* with the passage of time.

Possible origin: It is not clear how long *C. scylla* has been in Sri Lanka. Though several workers were very active in butterfly studies from about 1870 to 1950, there have been few people doing research on butterflies since then. The authors' own studies from 1960 to 2004 were sporadic and of short duration and the authors took only short occasional trips to the area where *C. scylla* seems to be most concentrated. It is possible that *C. scylla* was overlooked. However, it is

distinctive enough for a butterfly enthusiast to have spotted it if it was present in Sri Lanka earlier.

Though *S. surattensis* is an introduced plant, it has been recorded on the island since at least 1824 when it was listed by Moon (1824) in his catalogue as *Cassia glauca*. Moon reported it being found in Colombo and with the Sinhalese name of wal-ehela that is still in use today though it is now more commonly called "Malaysian ehela." The name wal-ehela is also applied to *Senna bacillaris*. Thwaites (1864) listed it with the same information as Moon. Trimen (1894) listed it saying that he knew it only as a "garden plant". Willis (1911) listed it but with no other information. Dassanayake (1991) listed it as an introduced ornamental but gives only a few locations. The Forest Department now supplies plants grown from local seeds as a horticultural plant and it is planted widely in home gardens. Its distribution is in the south-west quadrant of the island.

In the 1980's large specimens of *S. surattensis* were imported from the far east (probably Malaysia or Singapore) and planted extensively along major roadways including the highway A10. It is probable that *C. scylla* arrived here as eggs, larvae or pupae on this imported plant material and escaped detection as it passed through quarantine. It is highly unlikely that *C. scylla* flew across the sea because of the large distances involved; the closest populations are in Malaysia and Thailand and *C. scylla* would then likely have arrived on the east coast from which we have no records. It is also possible that adults came across on merchant vessels but there is no evidence yet to support this hypothesis.

Prospects for the future: *C. scylla* is likely to remain well-established in Sri Lanka because its larval food plant is widely distributed and is a popular, hardy garden plant. Since *C. scylla* feeds on a variety of plants in other countries, it is possible that it might cross over to feed on other species that are found in Sri Lanka such as *Senna didymobotrya, Cassia tora, C. spectabilis, C. fistula, C. obtusifolia* and *Tephrosia candida.*

Catopsilia species are noted for their ability to disperse widely and in great numbers and for their fluctuations in populations (Larsen, 1992). It is likely that the population structure of *C. scylla* will be similar to that of *C. pomona* with peak populations coinciding with the intermonsoonal rains (March/April and Sept/Oct). However, given its predisposition to lay eggs on older leaves and the ability of the larva to feed on them, *C. scylla* may have different flight periods and population peaks. The frequent flushing of *S. surattensis* throughout the year may also influence the population dynamics of the species as edible food material is available all year. We do not yet have enough data to quantify these observations.

However as *C. scylla* becomes more established, it will tend to become more susceptible to parasites and pathogens. Larvae collected in February 2008 all survived with no problems though a few pupae appeared to be infected with a fungus (Fig. 4e). In February 2010, many of the larvae that were collected died in the larval stage possibly due to a fungal infection, but in 2011-2012, larvae again were numerous and healthy. In 2008, *S. surattensis* trees were literally loaded with eggs, larvae and pupae at the same time. Now, only a few individuals (eggs or larvae) are seen on an individual plant. The most recent records, from December 2011, showed several eggs on only one tree out of 10 that were checked though in another area a few kilometers away, a single tree had several eggs and more than two dozen larvae of various instars.

S. surattensis is also used extensively by *Eurema blanda silhetana* as a larval food plant. *E. blanda silhetana* larvae are gregarious and so offer some competition to *C. scylla* though they feed only on young leaves unlike *C. scylla*. In the course of this study, a new larval food plant record was ascertained for *C. pomona*: its larvae were also found to feed on *S. surattensis*. *C. pomona* also feeds on older leaves and so may offer some competition. In addition, red tree ants (*Oecophylla smaragdina*), which prey on almost any living creature including butterfly larvae and pupae, often build their nests on *S. surattensis* plants. Female *C. scylla* carefully check the trees before laying their eggs and avoid laying on plants that harbor these ants.

Conclusion

Larsen (pers. comm.) and Pittaway *et al.* (2006) noted that "firm establishment of exotic butterflies is a very rare event. There are not more than 20–30 similar cases – and there are more than 18,600 recorded butterfly species worldwide (Larsen, 2005)". Though its numbers seem to have declined since the first sightings 4 years ago, this fits with the population characteristics of many species of *Catopsilia* that go through cycles of rapid expansion and then contraction. Though the data is somewhat scanty because of the lack of observers, *C. scylla* seems to be well-established in Sri Lanka with a good supply of larval food plants and a niche for its larvae. As we look through our window, we still see them flying.

Faunistic data

All records by the authors unless otherwise noted (ordered by location): Road A10, km 44 (5 ii 2010); road A10, km 58 (2008: 16

ii, 23 ii, 25-26 ii, 29 ii, 2 iii, 18 iii, 5 iv, 24 iv, 2 v, 3 vii, 22 ix, 24 ix, 2 xi, 20 xi, 3 xii. 2009: 17 i, 30 i, 18 ii, 9 x, 2 xii. 2010: 18 ii. 2011: 20 ii, 29 vi, 7 xii, 22 xii. 2012: 4 i, 10 i); Bandarakoswatte, road B79, coconut property at km 44 (2008: 4 ii, 18 ii, 25 ii, 6 iii, 12 iii, 7 iv, 8 iv, 21 iv, 12 vii, 30 ix, 7 x, 13 x, 5 xi, 10 xii, 15 xii, 22 xii, 29 xii. 2009: 7 i, 17 i, 26 i , 4 ii, 12 ii, 17 ii, 4 iii, 12 iii, 22 iii, 28 iii, 12 iv, 16 xi, 25 xi, 12 xii, 15 xii, 16 xii, 30 xii. 2010: 12 i, 14-15 i, 20 i, 15 ii, 3 iii, 16 iii. 2011: 24 i, 11 ii, 1 iii, 10 iii, 15 vi, 8 vii; 10 xii, 15 xii. 2012: 3 i, 8-10 i); Padeniya, road A10 (4 xii 2011); road A26, km 6 (9 vi 2009); road B79, km 17 (28 ii 2008); road B79, km 47 (6 iii 2008); road B79, km 53 (23 ii 2008); road B79, km 48 (2008: 22 v, 24 v, 19 vi, 2 xi, 20 xi. 2009: 3 xii); Balangoda/Rassagala Road (1 ix 2010); Bingiriya (14 ii 2010, A. Amarakoon, pers. comm.); Colombo (25 ix 2010, C. de Alwis, pers. comm.); Digana Kandy (24 ii 2009); Dolukanda Kurunegala (8 xi 2008, A. Amarakoon, pers. comm.); Embilipitiya (8 v 2008, D. Ranasinghe, pers. comm.); Galle (1 xi 2009, N. Thotawata, pers. comm.); Ganewatte Kurunegala (9 xii 2008); Hiyare Kuruduwatte Galle (1 xi 2009); Kandy (1 xi 2009, N. Thotawata, pers. comm., 26 xii 2009, A. Amarakoon, pers. comm.); Kochikade (31 x 2008); Koggala & Kottawa, Galle (-- 2008, Galle Biodiversity Survey); Pilassa near Kurunegala (23 iii 2008); road A10 at Mallawapitiya (2008: 20 ii, 1 iv); Nadugala Matara (-- 2009, Matara Biodiversity Survey); Open University Nawala (20 x 2009); Padeniya (20 ii 2008, 30 i 2009); Pannala (10 v 2008); Pannipitiya Colombo (5 xii 2008); Peradeniya (2010: 18 ii, 27 ii); Rajagiriya Colombo (2008: 4 iii, 28 iii, 30 v); Rumassala Galle (8 v 2008); Sri Jayawardenapura, Colombo (31 x 2008); Talangama Lake, Colombo (31 x 2008); Udawalawe (-- 2009, D. Ranasinghe, pers. comm.); Wakwella Galle (-- 2008, Galle Biodiversity Survey).

Dates of breeding (oviposition, eggs, larva or pupae were noted in the following months/years): at Bandarakoswatte—2008 (Feb, Mar, Apr, Jul, Dec); 2009 (Feb, Jun); 2010 (Feb); 2011 (Feb, Mar, Jun, Jul, Dec); 2012 (Jan); at Embilipitiya—May 2008.

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